CHAPTER 16

Service Flow Mapping to MPLS-VPN on the Cisco CMTS

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This document describes the Mapping Service Flows to MPLS VPN feature, which enhances the existing multiprotocol label switching (MPLS) virtual private networks (VPNs) support to provide more flexible Managed Access for multiple Internet Service Provider (ISP) support over a hybrid fiber-coaxial (HFC) cable network.

History for the Mapping Service Flows to MPLS VPN Feature

Release	Modification
12.2(11)BC2	This feature was supported on the Cisco uBR7100 series and Cisco uBR7200 series universal broadband routers.
12.3(13)BC	This feature was supported on the Cisco CMTS. Support was added for mapping dynamic service flows on the Cisco uBR7200 series and the Cisco uBR10000 series.

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at http://www.cisco.com/go/fn. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

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- Command Reference, page 16-20

Prerequisites for Mapping Service Flows to MPLS-VPN

This feature applies to all Cisco CMTS routers.

- To support static service-flow to MPLS-VPN functionality, the Cisco uBR7100 series and Cisco uBR7200 series routers must be running Cisco IOS Release 12.2(11)BC2 or later and the Cisco uBR10000 series routers must be running Cisco IOS Release 12.3(13)BC or later.
- To support dynamic service-flow to MPLS-VPN functionality, the Cisco uBR7100 series, the Cisco uBR7200 series, and the Cisco uBR10000 series routers must be running Cisco IOS Release 12.3(13)BC or later.
- All Cisco CMTS must be configured for the proper VPN routing/forwarding (VRF) interfaces, as specified by the documentation in the "Additional References" section on page 16-18.
- To support static service-flow to MPLS VPN mapping, your DOCSIS configuration file editor must support the inclusion of Vendor Specific Options (TLV subtype 43) in the Upstream Service Flow Encodings parameter set (TLV type 24). The new option to be added is called the VPN Route Distinguisher parameter (TLV subtype 4) and must be preceded by the Cisco Vendor ID (00000C).

  For example, using the Cisco DOCSIS Configurator tool, you would specify the following fields in the ASCII configuration file:

```
24 (Upstream Service Flow Block)
  S43 (Vendor Specific Options)
   T08 (Vendor ID) = 00 00 0c
   T04 (VPN Route Distinguisher) = xx xx xx xx xx xx xx xx
```

  where the VPN Route Distinguisher (RD) contains eight hexadecimal bytes. The first two hexadecimal bytes specify the format of the remaining six bytes:

  - If bytes 1 and 2 are 00 00, bytes 3 and 4 specify the 16-bit autonomous system (AS) number, and bytes 5 to 8 specify a unique 32-bit identifier.
  - If bytes 1 and 2 are 00 01, bytes 3 to 6 specify the 32-bit IP address, and bytes 7 and 8 specify a unique 16-bit identifier.

  Configure the VPN Route Distinguisher parameter to the same *route-distinguisher* ID that you have specified on the Cisco CMTS using the **rd** command in VRF configuration submode.
- To support DOCSIS configuration file-based dynamic service-flow to MPLS VPN mapping, your DOCSIS configuration file editor must support the inclusion of the Cisco Vendor Specific Dynamic Flow VPN RD parameter (TLV subtype 13).

  For example, using the Cisco DOCSIS Configurator tool, you would specify the following fields in the ASCII configuration file:

```
43 (Vendor Specific Info)
    S8 (Vendor ID)  = 0-0-c
    S13 (Dynamic Flow VPN RD)  = xx xx xx xx xx xx xx xx
```

  where the eight-byte VPN RD uses the same format as specified above.

Restrictions for Mapping Service Flows to MPLS-VPN

The Mapping Service Flows to MPLS VPN feature has the following restrictions and limitations:

- Cable modems using the static service-flow to MPLS-VPN mapping feature should use a unique DOCSIS configuration file that creates an upstream packet classifier and service flow corresponding to each CPE or MTA device that needs to have its traffic routed to a different MPLS VPN than the MPLS VPN to which the cable modem natively belongs.
- The DOCSIS configuration file for a cable modem must be updated whenever a CPE device that needs to use a different MPLS VPN than the cable modem's native MPLS VPN is added or removed, or whenever the MAC address for a CPE device changes. The cable modem must also be reset to execute the changes in the DOCSIS configuration file.
- By default, dynamically generated upstream service flows use the MPLS VPN with which a cable modem is natively associated. In order to specify a different MPLS VPN for use by dynamically generated upstream service flows, it is necessary to do one of the following:
  - Specify an RD in the Cisco Vendor Specific Info Subtype Option 13 within the cable modem's DOCSIS configuration file.
  - Use the global or cable interface command **cable dynamic-flow vrf** *vrf-name* to specify an MPLS VPN name. See cable dynamic-flow vrf, page 16-21.

Information About Mapping Service Flows to MPLS-VPN

The Mapping Service Flows to MPLS VPN feature provides the following benefits to cable service providers and their partners and customers:

- Allows the service provider to maintain full control over the cable modems and other devices that are directly connected to the cable plant.
- Provides a highly flexible, scalable, and easy to manage system.
- Supports overlapping IP address ranges.
- Provides secure support for multiple intranets and extranets.
- Supports multiple IP Quality of Service (QoS) classes.
- On the Cisco uBR7200 series and the Cisco uBR10000 series, supports the mapping of dynamic service flows to an MPLS VPN, by means of (1) the **cable dynamic-flow vrf** command, or (2) the use of the Dynamic Flow VPN RD parameter (Cisco Vendor Specific Info Subtype 13) within a DOCSIS configuration file.

The Cisco CMTS routers provide managed access by means of MPLS VPNs configured over cable subinterfaces, with each subinterface configured for a specific ISP and each cable modem associating itself and all connected CPE to a specific subinterface. This use of MPLS VPNs gives service providers a manageable way to offer users access to multiple ISPs over the same physical HFC cable network.

This system works very well when all CPE devices behind a cable modem are using the same ISP. However, users are increasingly requesting more complex networks that would allow multiple CPE devices to access different ISPs through the same cable modem.

For example, different users in one household might want to use different PCs to access different ISPs. Another increasingly common situation is that one user requires a secure VPN connection for telecommuting through one ISP, while other users in the household use other computers to access the public Internet through a separate ISP.

As another example, a service provider offering a PacketCable voice over IP (VoIP) service may wish to allow one ISP to manage and operate the voice component of the cable network, and another to manage and operate the data component.

The Mapping Service Flows to MPLS VPN feature solves this problem by using DOCSIS 1.1 upstream packet classifiers and service flow IDs (SFIDs) to map individual CPE devices to separate MPLS-VPN interfaces. The SFID to MPLS-VPN mapping occurs as follows:

1. The service provider creates for each cable modem a DOCSIS configuration file that contains the following information:
   - Secondary upstream service flows that specify QoS profiles for CPE devices that must be associated with a particular MPLS VPN where that MPLS VPN is different from the cable modem's native MPLS VPN assignment.
   - For each upstream service flow, a Vendor Specific QoS Parameter (TLV type 43, subtype 04) that identifies the MPLS VPN route distinguisher (RD) for packets using this particular service flow.
   - Upstream packet classifiers that correspond to the secondary upstream service flows, so that the cable modem may direct packets from the CPE in question to the correct service flows. To accomplish this, each classifier must contain the MAC address of CPE that are to be associated with the service flow and consequently with the MPLS VPN. This would typically be accomplished by making use of the Source MAC Address parameter (TLV type 10, subtype 2).

   Note The DOCSIS configuration file also must create a primary downstream and a primary upstream service flow and packet classifier, as well as other required parameters, but these are not used for the SFID to MPLS-VPN mapping.

2. The cable modem downloads the DOCSIS configuration file during its registration process and configures itself for the proper service flows and packet classifiers.
3. The cable modem then comes online, at which point it begins receiving packets from its CPE devices. The cable modem uses the packet's source MAC address to match the packet to the proper packet classifier, which then identifies the correct SFID to use. The cable modem then transmits the packet to the Cisco CMTS using this upstream SFID.
4. The Cisco CMTS examines the packet to determine its SFID, and then uses the Vendor-Specific QoS Parameter associated with that service flow to route the packet to the appropriate MPLS-VPN interface.
5. When a dynamic upstream service flow is generated, as in the case with a PacketCable VoIP phone call, the CMTS determines the MPLS VPN to associate the new upstream service flow by one of several methods in the following order of precedence:
   a. If the cable modem's DOCSIS configuration file contains the Dynamic Flow VPN RD parameter (Cisco Vendor Specific Info Subtype 13), then the dynamic service flow's VPN is set to the one using the RD as specified in the parameter.
   b. If the cable interface on which the modem is online has had the **cable dynamic-flow vrf** command applied, then the dynamic service flow's VPN is set to the MPLS VPN specified by that command.
   c. If the global **cable dynamic-flow vrf** command is applied, then the dynamic service flow's VPN is set to the MPLS VPN specified by this command.
   d. Finally, the dynamic service flow's VPN is set to the VPN to which the cable modem is associated.

If the DOCSIS configuration file for the cable modem does not contain an MPLS-VPN route, the packets from that cable modem are routed according to the routing tables on the Cisco CMTS.

Supported Platforms

The Mapping Service Flows to MPLS VPN feature is supported on the following platforms:

- Cisco uBR7100 series universal broadband routers
- Cisco uBR7200 series universal broadband routers
- Cisco uBR10000 series universal broadband routers

Configuration Tasks

See the following section for the configuration tasks to configure the Mapping Service Flows to MPLS VPN feature. Each task in the list is identified as either required or optional.

- Creating a DOCSIS Configuration File (Required), page 16-5
- Mapping Dynamic Service Flows, page 16-7

Note This section describes only the configuration tasks needed to enable the Mapping Service Flows to MPLS VPN feature. It does not describe the basic MPLS-VPN configuration tasks. For information on configuring MPLS-VPN routes, see the documentation listed in the "Additional References" section on page 16-18.

Creating a DOCSIS Configuration File (Required)

The Cisco CMTS automatically map service flows to MPLS-VPN interfaces when an upstream service flow includes the VPN Route Distinguisher parameter as a vendor-specific TLV. The VPN Route Distinguisher parameter points to the *route-distinguisher* ID that has been specified using the **rd** command in VRF configuration submode.

You must also create a corresponding upstream packet classifier that identifies the source MAC address that will use this SFID-to-MPLS VPN mapping. To create a DOCSIS configuration file that contains both of these parameters, use the following procedure.

Note This procedure uses the Cisco DOCSIS Configurator tool to create the DOCSIS configuration file. However, you can use any tool that creates DOCSIS-compatible configuration files.

Note For information about the **rd** command, see http://www.cisco.com/en/US/docs/ios/12_2/switch/command/reference/xrfscmd4.html

Step 1 Obtain the MAC addresses for the CPE devices that must be associated with a different MPLS VPN than the cable modem's native MPLS VPN association.

Step 2 Create an upstream packet classifier for each CPE device, specifying the service flow reference of the appropriate upstream service flow and the source MAC address of the CPE, along with the other appropriate parameters. For example, the following configuration for classifier 14 specifies that the service flow with service flow reference 7 should be used for the MAC address at 00 00 0C A1 B2 C3:

```
22 (Upstream Packet Classification Encoding Block)
```

```
   S01 (Classifier Reference)           = 14
   S03 (Service Flow Reference)         = 7
   S10 (Ethernet LLC Packet Classification Encodings)
       T02 (Source MAC Address)         = 00 00 0C A1 B2 C3
```

Step 3 Create a matching upstream service flow for this CPE device. This service flow must include all necessary parameters, as well as a vendor-specific VPN Route Distinguisher parameter (TLV subtype 4) that identifies the route-distinguisher ID for the VRF route that has been created for this user.

The route-distinguisher ID consists of two integers that can be in the following two forms:

- Type 0—Contains a 16-bit autonomous system (AS) number and a unique 32-bit identifier
- Type 1—Contains a 32-bit IP address and a unique 16-bit identifier

Configure the VPN Route Distinguisher parameter to the same *route-distinguisher* ID that you have specified on the Cisco CMTS using the **rd** command in VRF configuration submode. For example, if you configured a type 0 route using the following CLI commands:

```
ip vrf isp1
 rd 64000:1
```

Configure the matching upstream service flow with the following parameters:

```
24 (Upstream Service Flow Encodings)
   S43 (Vendor Specific Options) = 8.3.0.0.12.4.8.0.0.250.0.0.0.0.1
```

The Vendor Specific Options field translates into two TLVs. The first TLV is of type 8 (Vendor ID), length 3, and value of 00.00.0C hexadecimal to identify Cisco Systems. The second TLV is of type 4 (VPN Route Distinguisher), length 8, and value of 00.00.FA.0.0.0.0.1 (hexadecimal).

Tip If you are using the graphical interface in the Cisco DOCSIS Configurator tool to create the DOCSIS configuration file, enter the entire dotted decimal string into the "Vendor Specific QoS" field in the Upstream and Downstream Service Flow screens. Using the above example, you would enter "8.3.0.0.12.4.8.0.0.0.250.0.0.0.1" into this field.

Similarly, if you configured a type 1 route using the following CLI commands:

```
ip vrf isp2
 rd 10.10.10.15:1
```

Configure the matching upstream service flow with the following parameters:

```
24 (Upstream Service Flow Encodings)
   S43 (Vendor Specific Options) = 8.3.0.0.12.4.8.0.1.10.10.10.15.0.1
```

Similarly, the Vendor Specific Options field translates into two TLVs. The first TLV is of type 8 (Vendor ID), length 3, and value of 00.00.0C hexadecimal to identify Cisco Systems. The second TLV is of type 4 (VPN Route Distinguisher), length 8, and value of 00.01.0A.0A.0A.0F.00.01 (hexadecimal).

Step 4 Repeat this procedure for each upstream packet classifier and service flow that is to be mapped to an MPLS-VPN interface.

Mapping Dynamic Service Flows

If the MPLS VPN to which dynamic service flows are mapped must be set on a per-cable-modem basis, rather than on a per-cable-interface or per-Cisco- CMTS basis, then the Dynamic Flow VPN RD parameter (Cisco Vendor Specific Info Subtype 13) must be added to the DOCSIS configuration. The Dynamic Flow VPN RD parameter is used to specify the route-distinguisher ID for the VRF route that has been created for use by dynamic service flows.

Note In general, the MPLS VPN to which dynamic service flows must be mapped should be the same MPLS VPN as specified for static service-flow to MPLS VPN mapping.

Step 1 Refer to Step 3 of Creating a DOCSIS Configuration File (Required), page 16-5.

Step 2 Configure the VPN Route Distinguisher parameter to the same route-distinguisher ID that you have specified on the Cisco CMTS by means of the **rd** command in VRF configuration submode. For example, if you configured a type 0 route by means of the following CLI commands:

```
ip vrf isp1
rd 64000:1
```

configure the matching Dynamic Flow VPN RD parameter as follows:

```
43 (Vendor Specific Info)
    S8 (Vendor ID)  = 0-0-c
    S13 (Dynamic Flow VPN RD)  = 0-0-fa-0-0-0-0-1
```

The Vendor Specific Options field translates into two TLVs:

- The first TLV is of type 8 (Vendor ID), length 3, and value of 00.00.0C (hexadecimal), to identify Cisco Systems.
- The second TLV is of type 4 (VPN Route Distinguisher), length 8, and value of 00.00.FA.0.0.0.0.1 (hexadecimal).

Similarly, if you configured a type 1 route by means of the following CLI commands:

```
ip vrf isp2
rd 10.10.10.15:1
```

configure the matching upstream service flow with the following parameters:

```
43 (Vendor Specific Info)
    S8 (Vendor ID)  = 0-0-c
    S13 (Dynamic Flow VPN RD)  = 0-1-a-a-a-f-0-1
```

Similarly, the Vendor Specific Options field translates into two TLVs:

- The first TLV is of type 8 (Vendor ID), length 3, and value of 00.00.0C (hexadecimal) to identify Cisco Systems.
- The second TLV is of type 4 (VPN Route Distinguisher), length 8, and value of 00.01.0A.0A.0A.0F.00.01 (hexadecimal).

The per-cable-modem Dynamic Flow VPN RD parameter takes precedence over any per-cable-interface or per-Cisco-CMTS dynamic service flow to MPLS VPN configuration.

Step 3 If the MPLS VPN to which dynamic service flows are mapped must be set on a per-cable-interface basis, as opposed to per cable modem or per Cisco CMTS, then use the following the cable interface configuration command:

```
Router# interface cable x/y/z
```

```
Router(config-if)# cable dynamic-flow vrf vrf-name
```

For example, if you configured the following VRF for use with dynamically generated service flows:

```
ip vrf isp1
 rd 64000:1
```

then you could use the following per-cable-interface command to ensure that dynamic service flows are mapped:

```
Router# interface cable x/y/z
Router(config-if)# cable dynamic-flow vrf isp1
```

The per-cable-interface dynamic service flow to MPLS VPN configuration takes precedence over the global per-Cisco-CMTS dynamic service flow to MPLS VPN configuration, but not over the per-cable-modem Dynamic Flow VPN RD parameter.

Step 4 If the MPLS VPN to which dynamic service flows are mapped must be set on a per-Cisco-CMTS basis, as opposed to per cable modem or per cable interface, then use the global configuration command:

```
Router# cable dynamic-flow vrf vrf-name
```

For example, if you configured the following VRF for use with dynamically generated service flows:

```
ip vrf isp2
 rd 10.10.10.15:1
```

then you could use the following per-cable-interface command to ensure that dynamic service flows are mapped:

```
Router# interface cable x/y/z
Router(config-if)# cable dynamic-flow vrf isp2
```

Monitoring and Maintaining the Mapping Service Flows to MPLS VPN Feature

This section provides examples of the CLI commands that show the configuration and current status of the cable modems (CMs) that are using the Mapping Service Flows to MPLS VPN feature. These examples display a number of CMs that are online, and the last CM [with the primary service identifier (SID) of 6] has three CPE devices connected to separate ISPs.

Displaying CMs and CPE devices

To display the number of CMs that are currently registered and online, use the **show cable modem** command:

```
Router# show cable modem

MAC Address    IP Address      I/F       MAC         Prim RxPwr  Timing  Num BPI
                                         State       Sid  (db)   Offset  CPE Enb
0030.8047.b41f 5.108.1.21      C3/0/U2   online(pt)  1    0.75   2821    0   Y
0007.0e03.1349 5.109.1.9       C3/0/U0   online      2   *0.00   2816    0   N
0007.0e03.12bd 5.108.1.18      C3/0/U0   online(pt)  3    -0.25  2812    0   Y
0030.80bc.22d5 5.108.1.20      C3/0/U0   online(pt)  4    0.25   2819    0   Y
0007.0e03.1331 5.111.1.6       C3/0/U0   online      5    -0.25  2816    0   N
00a0.73b0.4cc1 5.110.1.6       C3/0/U0   online(pt)  6    -0.25  2990    3   Y

Router#
```

To display the CPE devices that are associated with each CM, use the **show interface cable modem** command:

```
Router# show interface cable 3/0 modem 0

SID   Priv bits  Type      State     IP address      method    MAC address
1     11         modem     up        5.108.1.21      dhcp      0030.8047.b41f
2     00         modem     up        5.109.1.9       dhcp      0007.0e03.1349
3     11         modem     up        5.108.1.18      dhcp      0007.0e03.12bd
4     11         modem     up        5.108.1.20      dhcp      0030.80bc.22d5
5     00         modem     up        5.111.1.6       dhcp      0007.0e03.1331
6     11         modem     up        5.110.1.6       dhcp      00a0.73b0.4cc1
6     11         host      unknown   131.1.2.30      dhcp      0002.e323.ac08
6     11         host      unknown   129.1.2.18      dhcp      0050.046b.8b97
6     11         host      unknown   130.1.2.24      dhcp      0050.da80.c13e

Router#
```

To display the MPLS VPN Route Distinguisher (RD) to be used by dynamic service flows from a cable modem using the Dynamic Flow VPN RD parameter (Cisco Vendor Specific Info Subtype 13), use the **show cable modem verbose** command:

Note The dynamic mapping is highlighted below.

```
Router# show cable modem 0007.0e02.afa5 verbose

MAC Address                     : 00a0.73b0.4cc1
IP Address                      : 5.110.1.6
Prim Sid                        : 6
```

```
Interface                           : C3/0/U0
sysDescr                            :
Upstream Power                      : 0.00 dBmV (SNR = 33.83 dB)
Downstream Power                    : 0.00 dBmV (SNR = ----- dB)
Timing Offset                       : 2290
Initial Timing Offset               : 2290
Received Power                      :  0.00 dBmV
MAC Version                         : DOC1.1
QoS Provisioned Mode                : DOC1.1
Enable DOCSIS2.0 Mode               : Y
Phy Operating Mode                  : tdma
Capabilities                        : {Frag=Y, Concat=Y, PHS=Y, Priv=BPI+}
Sid/Said Limit                      : {Max US Sids=4, Max DS Saids=0}
Optional Filtering Support          : {802.1P=N, 802.1Q=N}
Transmit Equalizer Support          : {Taps/Symbol= 1, Num of Taps= 8}
Number of CPE IPs                   : 0(Max CPE IPs = 16)
CFG Max-CPE                         : 5
Flaps                               : 0()
Errors                              : 0 CRCs, 0 HCSes
Stn Mtn Failures                    : 0 aborts, 0 exhausted
Total US Flows                      : 1(1 active)
Total DS Flows                      : 1(1 active)
Total US Data                       : 1606 packets, 129106 bytes
Total US Throughput                 : 43 bits/sec, 0 packets/sec
Total DS Data                       : 28 packets, 1792 bytes
Total DS Throughput                 : 0 bits/sec, 0 packets/sec
Active Classifiers                  : 0 (Max = NO LIMIT)
DSA/DSX messages                    : permit all
Dynamic Secret                      : 4E7AD0AEA48F94DE0EB773494B57EA74
Dynamic flows mapped to VPN RD      : 64000:1
Total Time Online                   : 1d3h
```

Displaying SID and MPLS Mappings

To display the mapping of currently used SIDs to SFIDs and their current state, use the **show interface cable sid verbose** command:

```
Router# show interface cable 3/0 sid verbose
Sid  Prim  MAC Address    IP Address      Type Age      Admin   Sched  Sfid
                                                       State   Type
1          0030.8047.b41f 5.108.1.21      stat 3h43m    enable  RSVD   3
2          0007.0e03.1349 5.109.1.9       stat 3h43m    enable  RSVD   5
3          0007.0e03.12bd 5.108.1.18      stat 3h43m    enable  BE     7
4          0030.80bc.22d5 5.108.1.20      stat 3h43m    enable  BE     9
5          0007.0e03.1331 5.111.1.6       stat 3h42m    enable  BE     11
6          00a0.73b0.4cc1 5.110.1.6       stat 08:19    enable  BE     13
7    6     00a0.73b0.4cc1 5.110.1.6       stat 08:19    enable  BE     15
8    6     00a0.73b0.4cc1 5.110.1.6       stat 08:19    enable  BE     16
9    6     00a0.73b0.4cc1 5.110.1.6       stat 08:19    enable  BE     17
10   6     00a0.73b0.4cc1 5.110.1.6       dyn  02:35    enable  UGS    18

Router#
```

To display the mappings between SFIDs and the MPLS VPN subinterface, use the **show interface cable sid association** command:

```
Router# show interface cable 3/0 sid association

Sid  Prim Online     IP Address      MAC Address    Interface     VRF Name
1          online(pt) 5.108.1.21      0030.8047.b41f Bu1.101       isp1
2          online     5.109.1.9       0007.0e03.1349 Bu1.102       isp2
3          online(pt) 5.108.1.18      0007.0e03.12bd Bu1.101       isp1
4          online(pt) 5.108.1.20      0030.80bc.22d5 Bu1.102       isp1
5          online     5.111.1.6       0007.0e03.1331 Bu1.102       isp2
6          online(pt) 5.110.1.6       00a0.73b0.4cc1 Bu1.103       isp3
7    6                                              Bu1.101       isp1
8    6                                              Bu1.102       isp2
9    6                                              Bu1.103       isp3
10   6                                              Bu1.102       isp2

Router#
```

Displaying Service Flow Configurations

To display the basic mapping of service flows and packet classifiers, use the **show interface cable service-flow** command. To display complete service flow configuration information, add the **verbose** keyword.

The following example displays the service flow information for the CM that is using the primary SID of 6 and the SFID of 13:

```
Router# show interface cable 3/0 service-flow 13
Sfid  Sid   Mac Address     QoS Param Index   Type    Dir    Curr   Active
                           Prov  Adm  Act                   State  Time
13    6     00a0.73b0.4cc1   7     7    7     prim    US     act    12:59

Router# show interface cable 3/0 13 verbose

Sfid                                  : 13
Mac Address                           : 00a0.73b0.4cc1
Type                                  : Primary
Direction                             : Upstream
Current State                         : Active
Current QoS Indexes [Prov, Adm, Act]  : [7, 7, 7]
Active Time                           : 13:02
Sid                                   : 6
Traffic Priority                      : 0
Maximum Sustained rate                : 0 bits/sec
Maximum Burst                         : 3044 bytes
Minimum Reserved Rate                 : 0 bits/sec
Admitted QoS Timeout                  : 200 seconds
Active QoS Timeout                    : 0 seconds
Packets                               : 13
Bytes                                 : 1833
Rate Limit Delayed Grants             : 8
Rate Limit Dropped Grants             : 0
Current Throughput                    : 0 bits/sec, 0 packets/sec
Classifiers: NONE

Router#
```

The following example displays the service flow information for the first CPE device that is using the CM that is using the primary SID of 6. This CPE device is using a secondary SID of 7 and the SFID of 15, and is using the VRF configuration named **isp1**.

```
Router# show interface cable 3/0 15
Sfid  Sid   Mac Address     QoS Param Index   Type    Dir    Curr   Active
                           Prov  Adm  Act                   State  Time
15    7     00a0.73b0.4cc1   8     8    8     sec(S)  US     act    13:33

Router# show interface cable 3/0 15 verbose

Sfid                                  : 15
Mac Address                           : 00a0.73b0.4cc1
Type                                  : Secondary(Static)
Direction                             : Upstream
Current State                         : Active
Current QoS Indexes [Prov, Adm, Act]  : [8, 8, 8]
Active Time                           : 13:36
Sid                                   : 7
Traffic Priority                      : 0
Maximum Sustained rate                : 1000000 bits/sec
Maximum Burst                         : 65224 bytes
Minimum Reserved Rate                 : 0 bits/sec
Admitted QoS Timeout                  : 0 seconds
Active QoS Timeout                    : 0 seconds
Packets                               : 56
Bytes                                 : 8608
Rate Limit Delayed Grants             : 0
Rate Limit Dropped Grants             : 0
Current Throughput                    : 0 bits/sec, 0 packets/sec
Classifiers:

Classifier Id                      : 1
Service Flow Id                    : 15
CM Mac Address                     : 00a0.73b0.4cc1
Direction                          : upstream
Activation State                   : active
Classifier Matching Priority       : 0
PHSI                               : 0
Number of matches                  : -
Ethernet/LLC Classifier Parameters:
        Source MAC                 : 0000.0CA1.B2C3

Router#
```

The following example displays the service flow information for the second CPE device that is using the CM that is using the primary SID of 6. This CPE device is using a secondary SID of 8 and the SFID of 16, and is using the VRF configuration named **isp2**.

```
Router# show interface cable 3/0 service-flow 16
Sfid  Sid   Mac Address     QoS Param Index   Type    Dir    Curr   Active
                           Prov  Adm  Act                   State  Time
16    8     00a0.73b0.4cc1   8     8    8     sec(S)  US     act    14:04

Router#

Router# show interface cable 3/0 service-flow 16 verbose

Sfid                                  : 16
Mac Address                           : 00a0.73b0.4cc1
Type                                  : Secondary(Static)
Direction                             : Upstream
Current State                         : Active
Current QoS Indexes [Prov, Adm, Act]  : [8, 8, 8]
Active Time                           : 14:08
Sid                                   : 8
Traffic Priority                      : 0
Maximum Sustained rate                : 1000000 bits/sec
Maximum Burst                         : 65224 bytes
Minimum Reserved Rate                 : 0 bits/sec
Admitted QoS Timeout                  : 0 seconds
Active QoS Timeout                    : 0 seconds
Packets                               : 155
Bytes                                 : 20418
Rate Limit Delayed Grants             : 0
Rate Limit Dropped Grants             : 0
Current Throughput                    : 0 bits/sec, 0 packets/sec
Classifiers:

Classifier Id                     : 2
Service Flow Id                   : 16
CM Mac Address                    : 00a0.73b0.4cc1
Direction                         : upstream
Activation State                  : active
Classifier Matching Priority      : 0
PHSI                              : 0
Number of matches                 : -
Ethernet/LLC Classifier Parameters:
        Source MAC                : 0000.0CA1.B2D4

Router#
```

The following example displays the service flow information for the third CPE device that is using the CM that is using the primary SID of 6. This CPE device is using a secondary SID of 9 and the SFID of 17, and is using the VRF configuration named **isp3**.

```
Router# show interface cable 3/0 service-flow 17

Sfid  Sid   Mac Address     QoS Param Index   Type    Dir    Curr   Active
                           Prov  Adm  Act                   State  Time
17    9     00a0.73b0.4cc1   8     8    8     sec(S)  US     act    14:33

Router# show interface cable 3/0 service-flow 17 verbose

Sfid                                  : 17
Mac Address                           : 00a0.73b0.4cc1
Type                                  : Secondary(Static)
Direction                             : Upstream
Current State                         : Active
Current QoS Indexes [Prov, Adm, Act]  : [8, 8, 8]
Active Time                           : 14:36
Sid                                   : 9
Traffic Priority                      : 0
Maximum Sustained rate                : 1000000 bits/sec
Maximum Burst                         : 65224 bytes
Minimum Reserved Rate                 : 0 bits/sec
Admitted QoS Timeout                  : 0 seconds
Active QoS Timeout                    : 0 seconds
Packets                               : 141
Bytes                                 : 16152
Rate Limit Delayed Grants             : 0
Rate Limit Dropped Grants             : 0
Current Throughput                    : 33 bits/sec, 0 packets/sec
Classifiers:

Classifier Id                     : 3
Service Flow Id                   : 17
CM Mac Address                    : 00a0.73b0.4cc1
Direction                         : upstream
Activation State                  : active
Classifier Matching Priority      : 0
PHSI                              : 0
Number of matches                 : -
Ethernet/LLC Classifier Parameters:
        Source MAC                : 0000.0CA1.B2E5

Router#
```

The following example displays the service flow information for a dynamically generated PacketCable service flow on the modem with a primary SID of 6. The dynamic service flow is using a secondary SID of 10 and an SFID of 18, and is using the VRF configuration named isp2.

```
Router# show interface cable 3/0 service-flow 18 verbose

Sfid                         : 18
Mac Address                  : 00a0.73b0.4cc1
Type                         : Secondary(Dynamic)
Direction                    : Upstream
Current State                : Active
Current QoS Indexes [Prov, Adm, Act]: [0, 5, 5]
Active Time                  : 02:59
Sid                          : 10
Admitted QoS Timeout         : 200 seconds
Active QoS Timeout           : 0 seconds
Packets                      : 8967
Bytes                        : 2080344
Rate Limit Delayed Grants    : 0
Rate Limit Dropped Grants    : 0
Current Throughput           : 92399 bits/sec, 49 packets/sec
Classifiers:

Classifier Id                        : 1
Service Flow Id                      : 18
CM Mac Address                       : 00a0.73b0.4cc1
Direction                            : upstream
Activation State                     : active
Classifier Matching Priority         : 64
PHSI                                 : 0
Number of matches                    : -
IP Classification Parameters:
    IP Source Address           : 4.22.96.99
    Source IP Address Mask      : 255.255.255.255
    Destination IP Address      : 4.18.39.12
    Destination IP Address Mask : 255.255.255.255
    IP Protocol Type            : 17
    Source Port Low             : 16622
    Source Port High            : 16622
    Destination Port Low        : 17640
    Destination Port High       : 17640
```

Configuration Examples

This section provides the following configuration examples:

- DOCSIS Configuration File, page 16-16—Shows a cable modem being configured to support three MPLS VPN routes. This includes three upstream packet classifiers and three upstream service-flow parameter sets. It also shows the configuration required to have dynamic service flows associated with a particular MPLS VPN.
- MPLS VPN Interface Configuration, page 16-17—Shows the corresponding VRF configurations with the three VRF route-designators that match the MPLS-VPN configuration that is used on the cable modem.

DOCSIS Configuration File

```
CM-CONFIG
=========
03 (Net Access Control)         = 1
18 (Maximum Number of CPE)      = 100
28 (Max Number of Classifiers)  = 4
29 (Privacy Enable)             = 1

22 (Upstream Packet Classification Encoding Block)
   S01 (Classifier Reference)           = 10
   S03 (Service Flow Reference)         = 3
   S10 (Ethernet LLC Packet Classification Encodings)
       T02 (Source MAC Address)         = 00 00 0C A1 B2 C3

22 (Upstream Packet Classification Encoding Block)
   S01 (Classifier Reference)           = 12
   S03 (Service Flow Reference)         = 5
   S10 (Ethernet LLC Packet Classification Encodings)
       T02 (Source MAC Address)         = 00 00 0C A1 B2 D4

22 (Upstream Packet Classification Encoding Block)
   S01 (Classifier Reference)           = 14
   S03 (Service Flow Reference)         = 7
   S10 (Ethernet LLC Packet Classification Encodings)
       T02 (Source MAC Address)         = 00 00 0C A1 B2 E5

24 (Upstream Service Flow Encodings)
   S01 (Service Flow Reference)         = 1
   S06 (QoS Parameter Set Type)         = 7

25 (Downstream Service Flow Encodings)
   S01 (Service Flow Reference)         = 2
   S06 (QoS Parameter Set Type)         = 7

24 (Upstream Service Flow Encodings)
   S01 (Service Flow Reference)         = 3
   S06 (QoS Parameter Set Type)         = 7
   S08 (Max Sustained Traffic Rate)     = 1000000
   S09 (Maximum Traffic Burst)          = 65224
   S12 (Timeout Active QoS Parms)       = 0
   S13 (Timeout Admitted QoS Parms)     = 0
   S15 (Service Flow Sched Type)        = 2
   S43 (Vendor Specific Options) = 8.3.0.0.12.4.8.0.0.250.0.0.0.0.1

24 (Upstream Service Flow Encodings)
   S01 (Service Flow Reference)         = 5
```

```
   S06 (QoS Parameter Set Type)         = 7
   S08 (Max Sustained Traffic Rate)     = 1000000
   S09 (Maximum Traffic Burst)          = 65224
   S12 (Timeout Active QoS Parms)       = 0
   S13 (Timeout Admitted QoS Parms)     = 0
   S15 (Service Flow Sched Type)        = 2
   S43 (Vendor Specific Options) = 8.3.0.0.12.4.8.0.0.246.24.0.0.0.1

24 (Upstream Service Flow Encodings)
   S01 (Service Flow Reference)         = 7
   S06 (QoS Parameter Set Type)         = 7
   S08 (Max Sustained Traffic Rate)     = 1000000
   S09 (Maximum Traffic Burst)          = 65224
   S12 (Timeout Active QoS Parms)       = 0
   S13 (Timeout Admitted QoS Parms)     = 0
   S15 (Service Flow Sched Type)        = 2
   S43 (Vendor Specific Options) = 8.3.0.0.12.4.8.0.0.253.232.0.0.0.1

43 (Vendor Specific Info)
    S8 (Vendor ID)  = 0-0-c
    S13 (Dynamic Flow VPN RD)  = 0-0-fa-0-0-0-0-1

#<EOF>
```

MPLS VPN Interface Configuration

```
ip vrf MGMT
 rd 1:1
 route-target export 62000:1
 route-target import 62000:1
 route-target import 63000:1
 route-target import 64000:1
 route-target import 65000:1
!
ip vrf isp1
 rd 64000:1
 route-target export 64000:1
 route-target import 64000:1
 route-target import 62000:1
!
ip vrf isp2
 rd 63000:1
 route-target export 63000:1
 route-target import 63000:1
 route-target import 62000:1
!
ip vrf isp3
 rd 65000:1
 route-target export 65000:1
 route-target import 65000:1
 route-target import 62000:1
!
interface Bundle1
 no ip address
 hold-queue 1024 in
!
interface Bundle1.100
 ip vrf forwarding MGMT
 ip address 10.22.32.1 255.255.255.0
 cable dhcp-giaddr policy
 cable helper-address 4.104.0.66
!
```

```
interface Bundle1.101
 ip vrf forwarding isp1
 ip address 10.22.64.1 255.255.224.0
 ip address 4.22.64.1 255.255.224.0 secondary
 cable dhcp-giaddr policy
 cable helper-address 4.104.0.66
!
interface Bundle1.102
 ip vrf forwarding isp2
 ip address 10.22.96.1 255.255.224.0
 ip address 4.22.96.1 255.255.224.0 secondary
 cable dhcp-giaddr policy
 cable helper-address 4.104.0.66
!
interface Bundle1.103
 ip vrf forwarding isp3
 ip address 10.22.128.1 255.255.224.0
 ip address 4.22.128.1 255.255.224.0 secondary
 cable dhcp-giaddr policy
 cable helper-address 4.104.0.66
!
```

Additional References

The following sections provide references related to the Cisco CMTS routers.

Related Documents

Related Topic	Document Title
Cisco CMTS command reference	*Cisco Broadband Cable Command Reference Guide,* at the following URL: http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html
Cisco IOS Release 12.2	Cisco IOS Release 12.2 Configuration Guides and Command References, at the following URL: http://www.cisco.com/en/US/products/sw/iosswrel/ps1835/products_installation_and_configuration_guides_list.html http://www.cisco.com/en/US/products/sw/iosswrel/ps1835/prod_command_reference_list.html
Configuring cable features	*Cisco CMTS Feature Guide*, at the following URL: http://www.cisco.com/en/US/docs/cable/cmts/feature/guide/cmtsfg.html
Installing and configuring Cisco uBR7100 Series Universal Broadband Routers	Cisco uBR7100 Universal Broadband Routers, at the following URL: http://www.cisco.com/en/US/docs/cable/cmts/ubr7100/installation/guide/hig7100.html

Related Topic	Document Title
Installing and configuring Cisco uBR7200 Series Universal Broadband Routers	Cisco uBR7200 Universal Broadband Routers, at the following URL: http://www.cisco.com/en/US/docs/cable/cmts/ubr7200/installation/guide/ub72khig.html
Installing and configuring the Cisco uBR10012 Router	Cisco uBR10012 Universal Broadband Router, at the following URL: http://www.cisco.com/en/US/docs/cable/cmts/ubr10012/installation/guide/hig.html
Service provider solution	Cisco Cable-Ready High Speed Data (HSD) Managed Access Solution for Service Providers, which is at the following URL: http://www.cisco.com/en/US/netsol/ns3/networking_solutions_solution_category.html
MPLS VPN	Cisco uBR7200 Series MPLS VPN Cable Enhancements. **Note** The above document has reached End of Life. For more information, see the following End-of-Life Announcement at the following URL: http://www.cisco.com/en/US/docs/ios/redirect/eol.html
	MPLS Protocol, which is at the following URL: http://www.cisco.com/en/US/products/ps6557/products_ios_technology_home.html
	Cisco VPN Solution Center Software VPN Solutions Center: MPLS Solution Provisioning and Operations Guide, 1.2: **Note** This document has reached End of Life. For more information, see the following End-of-Life Announcement at the following URL: http://www.cisco.com/en/US/products/sw/netmgtsw/ps2327/prod_eol_notices_list.html

Standards

Standard	Title
DOCSIS	*Data-Over-Cable Service Interface Specifications Radio Frequency Interface Specification (SP-RFIv1.1-I08-020301)*

MIBs

No new or modified MIBs are supported by this feature.

RFCs

- RFC 1163, A Border Gateway Protocol

- RFC 1164, Application of the Border Gateway Protocol in the Internet
- RFC 2233, DOCSIS OSSI Objects Support
- RFC 2283, Multiprotocol Extensions for BGP-4
- RFC 2547, BGP/MPLS VPNs
- RFC 2665, DOCSIS Ethernet MIB Objects Support
- RFC 2669, Cable Device MIB

Technical Assistance

Description	Link
The Cisco Technical Support website contains thousands of pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/cisco/web/support/index.html

Command Reference

This section documents new commands only.

cable dynamic-flow vrf

To ensure that dynamic service flows are mapped, use the **cable dynamic-flow vrf** command in global or interface configuration mode (cable interface only). To disable this feature, use the **no** form of this command.

cable dynamic-flowvrf *vrf-name*

no cable dynamic-flowvrf *vrf-name*

Syntax Description

dynamic-flow	Enables the dynamic-flow option.
vrf	Enables the selection of a Virtual Routing and Forwarding instance.
vrf-name	The name of a selected VRF instance.

Command Default

None

Command Modes

Global and interface configuration (cable interface only).

Command History

Release	Modification
12.3(13(BC)	This command was introduced.

Usage Guidelines

When this command is applied on an interface, it overrides the global configuration.

Examples

The following example shows how to enable the mapping of dynamic service flows on Cisco CMTS interface 3/0 for VRF isp1:

```
Router(config-if)# cable dynamic-flow vrf isp1
```

The following example shows how to enable the mapping of dynamic service flows globally on a Cisco CMTS for VRF isp2:

```
Router# cable dynamic-flow vrf isp2
```

Related Commands

Command	Description
show cable modem verbose	Displays the MPLS VPN route distinguisher (RD) used by dynamic service flows from a cable modem using the Dynamic Flow VPN RD parameter (Cisco Vendor Specific Info Subtype 13).
show interface cable sid verbose	Displays dynamic SID mappings.

Command	Description
show interface cable sid association	Displays the association of SID, IP and MAC address, and VRF name.
show interface cable service-flow verbose	Displays service-flow information for dynamically generated service flows.